Electronic Services - Los Angeles
M12347X

GENERAL ELECTRIC CO.
INSTRUMENTATION &
METROLOGY LABORATORY
PHONE (213) 674-7900

936-6143

Instruction Manual

FLUKE

ELECTRONICS FOR INDUSTRY
INSTRUMENTS / COMPONENTS

JOHN FLUKE MFG. CO., INC.
P.O. Box 7428 Seattle, Washington 98133

APRIL 1, 1965

102

VAW® METER

Serial no. _____ and above

Copyright, John Fluke Mfg. Co., 1967

TABLE OF CONTENTS

Section	Title	Page
I	INTRODUCTION AND SPECIFICATIONS	1-1
	1-1. Introduction	1-1
	1-2. General Description	1-1
	1-4. Receiving Inspection	1-1
	1-6. Specifications	1-1
	1-7. Electrical	1-1
	1-8. Mechanical	1-1
II	OPERATING INSTRUCTIONS	2-1
	2-1. Controls, Terminals, and Indicators	2-1
	2-3. Operation	2-2
	2-8. Grounded Loads	2-2
	2-11. Measurement of Power Factor	2-3
	2-13. Correction of Readings	2-3
	2-22. Measuring Reactive Power	2-4
	2-24. Measuring Three-Phase Power	2-4
III	THEORY OF OPERATION	3-1
	3-1. Introduction	3-1
	3-3. Circuit Descriptions	3-1
IV	MAINTENANCE	4-1
	4-1. Introduction	4-1
	4-3. Preventive Maintenance	4-1
	4-5. Troubleshooting	4-1
	4-8. Calibration	4-2
V	LIST OF REPLACEABLE PARTS	5-1
	5-1. Introduction	5-1
	5-3. How to Obtain Parts	5-1
	5-7. Use Code Effectivity	5-10
	WARRANTY	
	CIRCUIT DIAGRAM	

Digitized by the Internet Archive
in 2025

https://archive.org/details/manualsplus_07535

LIST OF ILLUSTRATIONS

Figure	Title	Page
Frontispiece	102 VAW® Meter	iv
1-1.	Measurement Combinations	1-2
2-1.	Function of Controls, Terminals and Indicators	2-1
2-2.	Measurement of Power from a Grounded Generator to a Grounded Load	2-2
2-3.	Input of Model 102	2-3
2-4.	Resistance of Shunts	2-3
2-5.	Voltage and Power Corrections	2-4
2-6.	Measuring Three-Phase Power	2-4
3-1.	Error Contributed By Harmonics	3-2
4-1.	Troubleshooting (Sheet 1 of 2)	4-1
4-1.	Troubleshooting (Sheet 2 of 2)	4-2
4-2.	Equipment Required for Troubleshooting	4-2
5-1.	Final Assembly (Sheet 1 of 4)	5-6
5-1.	Final Assembly (Sheet 2 of 4)	5-7
5-1.	Final Assembly (Sheet 3 of 4)	5-8
5-1.	Final Assembly (Sheet 4 of 4)	5-9

MODEL 102 VAW® METER

SECTION I

INTRODUCTION AND SPECIFICATIONS

1-1. INTRODUCTION

1-2. GENERAL DESCRIPTION

1-3. The Fluke Model 102 VAW® Meter is capable of measuring voltage, current, and power over a wide frequency range. Because of its high sensitivity, it is capable of measuring power from microwatts to kilowatts. The instruments high input impedance and low shunt drop produces little error in the circuit under tests. Power measurements are without waveform error within the specified frequency range. The instrument is well suited to measure the power dissipated in both linear and non-linear loads, including amplifier loads.

1-4. RECEIVING INSPECTION

1-5. This instrument has been thoroughly checked and tested before being shipped from the factory. When the instrument is received, carefully inspect for any damage that may have occurred in transit. Shunts are packed in the same container as the Model 102, and should be located before disposing of the shipping container. If any damage is noted, follow the instructions outlined on the warranty page in the back of.this manual.

1-6. SPECIFICATIONS

1-7. ELECTRICAL

VOLTAGE RANGES: 1.5, 3, 6, 15, 30, 60, 150, 300, 600 Volts RMS Full Scale.

AMPERE RANGES: 0.0015, 0.003, 0.006, 0.015, 0.03, 0.06, 0.15, 0.3, 0.6, 1.5, 3, 6, 15, 30 RMS Amperes.

POWER RANGE: 225 micro-watts to 18 kilo-watts. (See Figure 1-1)

POWER FACTOR: Either 1 or 0.1.

FREQUENCY RANGE:
20 cps to 100 Kilocycles (power factor of 1)
20 cps to 40 Kilocycles (power factor of 0.1)

ACCURACY: (After corrections for shunt dissipation):
3% (power factor of 1, 20 cps to 40 Kilocycles)
10% (power factor of 1, 40 Kilocycles to 100 Kilocycles)
3% (power factor of 0.1, 20 cps to 20 Kilocycles)
10% (power factor of 0.1, 20 Kilocycles to 40 Kilocycles)

INPUT IMPEDANCE: 1 megohm, 25 pico-farads.

INPUT POWER: 117/220/234 volts, 50 to 60 cps, approximately 135 watts.

1-8. MECHANICAL

SIZE:
Cabinet Model-10" high x 12" deep x 13" wide.
Rack Model-10-1/2" high x 12" deep x 19" wide.

WEIGHT:
Cabinet Model-27 pounds, shipping weight 40 pounds.
Rack Model-25 pounds, shipping weight 38 pounds.

SHUNT RATING	VOLTAGE RANGE								
Amps.	1.5V	3.0V	6.0V	15V	30V	60V	150V	300V	600V
.0015	.00225	.0045	.009	.0225	.045	.09	.225	.45	.9
.003	.0045	.009	.018	.045	.09	.18	.45	.9	1.8
.006	.009	.018	.036	.09	.18	.36	.9	1.8	3.6
.015	.0225	.045	.09	.225	.45	.9	2.25	4.5	9.0
.030	.045	.09	.18	.45	.9	1.8	4.5	9.0	18
.060	.09	.18	.36	.9	1.8	3.6	9.0	18	36
.150	.225	.450	.90	2.25	4.5	9.0	22.5	45	90
.300	.45	.9	1.8	4.5	9.0	18	45.0	90	180
.600	.9	1.8	3.6	9.0	18.0	36	90	180	360
1.5	2.25	4.5	9.0	22.5	45	90	225	450	900
3.0	4.5	9.0	18	45	90	180	450	900	1800
6.0	9.0	18	36	90	180	360	900	1800	3600
15.0	22.5	45	90	225	450	900	2250	4500	9000
30	45.0	90.0	180	450	900	1800	4500	9000	18000

Figure 1-1. MEASUREMENT COMBINATIONS

NOTE: When POWER FACTOR switch is set to 0.1, multiply the watt values in the table above by 0.1.

SECTION II

OPERATING INSTRUCTIONS

2-1. CONTROLS, TERMINALS, AND INDICATORS

2-2. The location, reference designation, and functional description of external controls, terminals, and indicators of the Model 102 are given in Figure 2-1.

CONTROLS TERMINALS AND INDICATORS	LOCATION	REFERENCE DESIGNATION	FUNCTIONAL DESCRIPTION
Input Terminals H and G	Front Panel	H and G	H terminal is to be connected to high-potential generator terminal. G terminal is grounded to Model 102 case, and should be connected to the grounded terminal of the generator.
Output Terminals H and L	Front Panel	H and L	H terminal should be connected to one terminal of the load. L terminal should be connected to other load terminal. L terminal is above ground by a maximum of 0.045 volts.
Shunt Jacks	Front Panel		Provided for connecting an external shunt to the Model 102.
Meter	Front Panel	M1	Indicates the magnitude of voltage, current, or power, in the circuit being measured.
ZERO W control	Front Panel	P5	Used for setting the panel meter to zero.
VOLTS control	Front Panel	S1	Used for selecting the full-scale voltage range of meter response.
POWER FACTOR control	Front Panel	S3	Used for selecting the power factor range of 1 or 0.1.
V A W control	Front Panel	S2	Selects meter indication of either voltage(V), current (A), or watts (W).
Power ON control	Front Panel	S4	Applies line voltage to the primary of transformer T1.
Pilot Lamp	Front Panel		Indicates the application of line power to the instrument.
Fuse	Back Panel	F1	Protects the instrument from overload due to internal mal-function.

Figure 2-1. FUNCTION OF CONTROLS, TERMINALS, AND INDICATORS.

2-3. OPERATION

a. Connect the Model 102 to a 115 volt, 50-60 cycle power source, and allow the instrument to warm-up for five minutes. If the instrument is wired for 220/234 volts, connect to 220/234 volt source.

b. Connect the Model 102 to the generator and to the load. Connect the high potential generator terminal to either one of the H terminals. Connect the generator common terminal to the G terminal. Connect one of the load terminals to the remaining H terminal, and connect the remaining load terminal to the L terminal. Connections to the G and L terminals must not be interchanged, because the wattmeter will deflect below zero. (See paragraphs 2-8 through 2-10).

c. Connect a shunt of suitable rating to the shunt jacks. Figure 1-1 is a table of various shunt and voltage ranges which can be used.

d. Set the VOLTS control to the desired full-scale voltage range.

e. Set the POWER FACTOR control to 1.

f. Set the VAW® control to W.

g. Set the front-panel toggle switch to ON.

h. With no voltage or current from the generator, set the meter pointer to zero by rotation of the ZERO W control. Do not adjust this control during an input from the generator, since this may not produce a true zero position.

i. Apply power to the load from the generator.

j. Set the VAW® control to V. The meter will indicate the load voltage.

k. Set the VAW® control to A. The meter will indicate the load current.

l. Set the VAW® control to W. The meter will indicate the power to the load.

m. If the power indication is less than 1/10th of full scale, set the POWER FACTOR control to 0.1. The meter indication must then be divided by 10 to obtain the correct power measurement. Note that this feature should not be used to increase the meter deflection in lieu of using a shunt which will provide as near a full-scale deflection as possible.

2-4. Note that when the POWER FACTOR control is in the 1 position, full-scale power indication is equal to the product of the shunt rating multiplied by the position of the VOLTS control. For example, assume that a 0.600 ampere shunt is being used and the VOLTS control is set to 60. Full scale indication is then (0.6) (60)=36 watts. When the POWER FACTOR control is in the 0.1 position, the product of the shunt rating and the VOLTS control position must be divided by 10 in order to obtain the correct full-scale indication. In the preceeding example, full scale indication would be 3.6 watts, with the POWER FACTOR control set to 0.1.

2-5. The G terminal is electrically connected to the 102 case. If the external lead connected to the G terminal is above ground, then the case of the 102 will also be above ground. This difference in voltage level may constitute a shock hazard. Operation of the Model 102 above ground potential is not recommended.

2-6. The capability of the Model 102 to measure real power in highly reactive loads represents high sensitivity in power measuring equipment. Consequently, the POWER FACTOR control should remain in the 1 position, except when necessary to set to 0.1 to effect a measurement.

2-7. To prevent errors due to overload, it is desireable to measure voltage and current before measuring power. This will insure that the full-scale voltage and current ranges are adequate for the values being measured.

2-8. GROUNDED LOADS

2-9. It may be necessary to measure the power into a load that has one terminal grounded. If neither terminal of the generator is grounded, proceed as follows:

a. Connect the Model 102 to a 117 volt, 50-60 cycle source, and allow the instrument to warm-up for five minutes. If the instrument is wired for 220/234 volts, connect to 220/234 volts.

b. Connect the high-potential generator terminal to one H terminal, and connect the ungrounded generator common terminal to the L terminal. Connect the high-potential load terminal to the other H terminal, and connect the grounded load terminal to the G terminal.

c. It will be necessary to insulate the Model 102 case from any conducting path other than the instrument leads.

d. To enable the meter to deflect upscale, it will be necessary to interchange the connection of the two leads from the S-Can, pins 3 and 6. Refer to the schematic diagram.

e. Proceed with steps c through m of paragraph 2-3.

2-10. If, in addition to one terminal of the load being grounded, one terminal of the generator is also grounded. Proceed as follows:

a. Connect the Model 102 as shown in Figure 2-2. It is important that the transformer have a minimum capacitance between the primary winding and the secondary winding to avoid by-passing the shunt. With the transformer located as shown, the measurement will not be affected by the losses in the transformer.

b. To enable the meter to deflect upscale, it will be necessary to interchange the connection of the two leads from the S-Can, pins 3 and 6. Refer to the schematic diagram.

c. Proceed with steps c through m of paragraph 2-3.

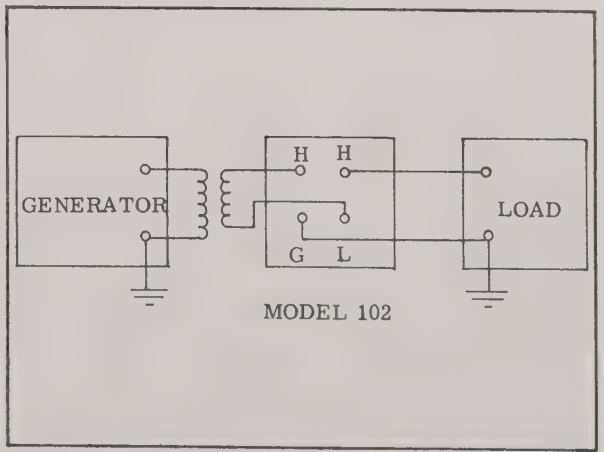


Figure 2-2. MEASUREMENT OF POWER FROM A GROUNDED GENERATOR TO A GROUNDED LOAD.

2-11. MEASUREMENT OF POWER FACTOR

2-12. The power factor of the circuit being measured can be determined as follows:

a. Set the POWER FACTOR switch to 1. (If the POWER FACTOR switch is set to 0.1, then full-scale represents a power factor of 10%).

b. Measure the voltage and current in the circuit as in steps j and k of paragraph 2-3.

c. Set the VAW® switch to W.

d. The value of Cos θ will be indicated by the meter. If the values of circuit voltage and current measured in step b. were less than full-scale, it will be necessary to multiply the meter indication by the product of the ratios of full-scale voltage to actual voltage and full-scale current to actual current, or:

$$\left(\frac{V_{\text{full-scale}}}{V_{\text{actual}}}\right) \quad \left(\frac{I_{\text{full-scale}}}{I_{\text{actual}}}\right)$$

For example, if the voltage and current were one-half of full scale, Cos θ indications must be multiplied by

$$\left(\frac{2}{1}\right)\left(\frac{2}{1}\right) = 4$$

2-13. CORRECTION OF READINGS

2-14. The Model 102 is an uncompensated wattmeter which utilizes for measurement the power consumed in the shunt. An input diagram of the usual connections of the Model 102 is given in Figure 2-3.

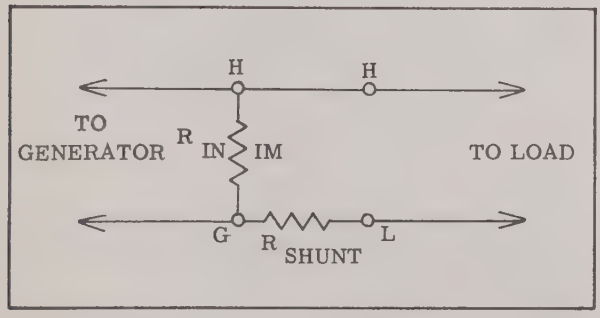


Figure 2-3. INPUT OF MODEL 102

2-15. From Figure 2-3, it is evident that the voltage and power measured by the wattmeter is not the actual voltage and power applied to the load. The measured values differ from the actual values due to the voltage drop across the shunt, which is 0.045 volts at rated current for any shunt. Because of the small voltage drop across the shunt, the error of voltage and power measurements is negligible in all except the lowest voltage ranges at 0.1 power factor.

2-16. The resistance of any shunt may be determined by dividing 0.045 volt by the rated shunt current. The resulting resistance values are tabulated in Figure 2-4.

SHUNT RATING AMPERES	SHUNT RESISTANCE OHMS	SHUNT RATING AMPERES	SHUNT RESISTANCE OHMS
.0015	30	.3	.15
.003	15	.6	.075
.006	7.5	1.5	.03
.015	3	3.0	.015
.03	1.5	6.0	.0075
.06	.75	15.0	.003
.15	.3	30.0	.0015

Figure 2-4. RESISTANCE OF SHUNTS

2-17. From Figure 2-3:

$$W_{actual} = W_{read} - W_{shunt}$$

$$W_{shunt} = (I_{read})^2 R_{shunt}$$

and:

$$V_{shunt} = I_{read} R_{shunt}$$

$$V_{actual} = V_{read} - V_{shunt}$$

Where:

W_{actual} = actual power consumed in the load (watts)

W_{read} = power indicated by Model 102 (watts)

W_{shunt} = power dissipated by shunt (watts)

I_{read} = current indicated by Model 102

R_{shunt} = resistance of shunt used, given in Fig. 2-4

V_{shunt} = voltage drop across shunt (0.045 volts maximum)

2-18. Voltage measurements can be corrected for shunt drop by subtracting the calculated shunt voltage from the meter indication. The error involved is small: for example, at the lowest voltage range of 1.5 volts, and full scale current, the error in voltage measurements is 0.045/1.5 = 3%. On the 3 volt range, and at full scale current, the error is 1.5%. For less than full-scale current, the full-scale error must be multiplied by the ratio of actual current to full-scale current. For example, if the current through the shunts in the above example were one-half of full-scale, then the computed error must be reduced by one-half.

2-19. Measurements of watts are not appreciably affected by shunt loss at a power factor of 1. However, the shunt loss must be subtracted from the meter indication for low voltage ranges at a power factor of 0.1. For example, assume that a 0.006 ampere shunt is being used at a power factor of 0.1, and on the 1.5 volt range.

VOLTS position	Per Centage Error in Voltage Measurement*	Per Centage Error in Watts Measurement at 0.1 power factor**	Per Centage Error in Watts Measurement at 1.0 power factor**
1.5	3%	30%	3%
3	1.5%	15%	1.5%
6	.75%	7.5%	.75%
15	.3%	3%	.3%
30	.15%	1.5%	.15%
60	.075%	.75%	.075%
150	.03%	.3%	.03%
300	.15%	.15%	.015%
600	.0075%	.075%	.0075%

* If the current is less than full-scale, error is to be multiplied by the ratio of actual current to full-scale current.

** If the current is less than full scale, error must be multiplied by the square of the ratio of actual current to full-scale current.

Figure 2-5. VOLTAGE AND POWER CORRECTIONS

Also assume full-scale current and voltage are indicated by the 102. From Figure 2-4, R_{shunt} is 7.5 ohms. Then:

$$W_{shunt} = (I_{read})^2 R_{shunt}$$
$$= (0.006)^2 7.5 = 0.00027 \text{ watts.}$$

$$W_{read} = (0.006)(1.5)(0.1) = 0.0009 \text{ watts.}$$

$$W_{actual} = W_{read} - W_{shunt}$$
$$= 0.0009 - 0.00027 = 0.00063 \text{ watts.}$$

In this example, shunt loss is 30% of the full-scale value, and must be subtracted from the meter indication.

2-20. It should be noted that with unity power factor in the preceeding example, the error would have been 3% of full scale. As the current is decreased from full-scale value, and as the volts setting is increased, the shunt loss correction rapidly becomes smaller.

2-21. Figure 2-5 is a summary of voltage and power corrections as a function of the position of the VOLTS control. Figure 2-5 is prepared for full-scale values of current, which causes a shunt voltage drop of 0.045 volts. To obtain correct measurements, subtract the percentage shown from the meter indication.

2-22. MEASURING REACTIVE POWER

2-23. The Model 102 measures only the real power in a circuit (i.e., the componet of power which is dissipated by pure resistance). However, the reactive power in a circuit can be determined by computation, as follows:

a. Measure the voltage and current in the circuit according to the procedure in paragraph 2-3.

b. Measure the power factor, Cos θ, as in paragraph 2-12.

c. Compute the phase angle, θ, from the measurement in step b.

d. Reactive power is computed by:

$$W_{reactive} = V_{read} A_{read} \text{ Sin } \theta$$

2-24. MEASURING THREE-PHASE POWER

2-25. The Model 102 may be used to measure three-phase power by any standard 2-wattmeter or 3-wattmeter method. Connections for a 2 wattmeter method are illustrated in Figure 2-6, where the subscripts refer to meter 1 and meter 2. The total power in the circuit is the algebraic sum of the readings of these two wattmeters. Under certain conditions of power factor, one of the meters may attempt to deflect down-scale. If this occurs, the connections of pins 3 and 6 of the S-Can in that meter must be reversed (see paragraph 2-8), to obtain up-scale deflection. The indication of that meter must then be subtracted from the other meter indication to obtain the correct power measurement for the circuit. It should be noted that the G terminal of the 102 is connected to the instrument case, which is grounded through the power line cord. In some cases, it may be necessary to isolate the 102 from ground, by using a line cord adapter with the instrument.

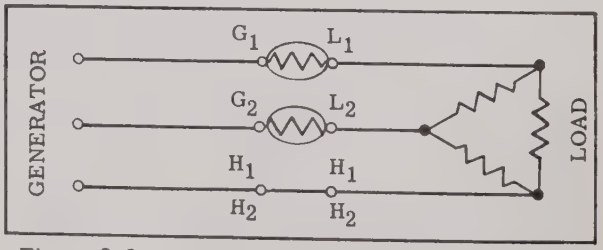


Figure 2-6. MEASURING THREE-PHASE POWER

SECTION III

THEORY OF OPERATION

3-1. INTRODUCTION

3-2. The amplifiers in the Model 102 have a response which is flat in amplitude and which introduces no phase shift over a minimum frequency range of 20 to 20,000 cycles per second. There are two main amplifier channels in the instrument. One channel amplifies a voltage proportional to circuit voltage, and the other channel amplifies a voltage proportional to circuit current. The output of each of these channels can be rectified and applied separately to a direct current meter. The gain of the voltage channel is adjusted to predetermined values by the VOLTS control. For measuring power the outputs from the voltage and current channels are applied to a multiplier, the output of which is proportional to the product of these two inputs and the cosine of their relative phase displacements. This multiplier contains no thermocouples, rectifiers, tubes, or moving parts.

3-3. CIRCUIT DESCRIPTIONS

3-4. The voltage channel is composed of S1, V1, and V9. Switch S1 provides attenuation of the input voltage. Electron tube V1 is a two-stage amplifier which provides amplification of a voltage proportional to the load voltage. The output of V1 is applied to V9, which functions as a vacuum tube voltmeter.

3-5. The current channel is composed of V4, V5, and V9. Tubes V4 and V5 provide two-stage amplification of the voltage across the shunt, which is proportional to load current. This amplified voltage is then applied to V9, which functions as a vacuum tube voltmeter.

3-6. Tube V9 is a dual-section tube which is connected as a vacuum tube voltmeter. The first section of the tube is used as an amplifier, the output of which is applied to the grid of section two. The output current from section two varies linearly with the voltage applied to the grid. The output current is rectified by diodes RE1 and RE2, and is applied to meter M1 through switch S2.

3-7. For measuring power, the output of the voltage channel and the current channel are combined. Tube V2 adds the voltage and current signals. The sum of these two voltages is then applied to V3, a cathode follower, which provides power amplification and applies the output to pin 5 of the multiplier. Tube V6 provides phase inversion of the current signal and tube V7 subtracts the voltage and current signals. The difference between these two voltages is then applied to V8, a cathode follower, which provides power amplification and applies the output to pin 4 of the multiplier. The multiplier provides the mathmetical function of squaring these two signals. This results in the following two voltages:

$$(V + A)^2 = V^2 + 2VA + A^2$$

$$(V - A)^2 = V^2 - 2VA + A^2$$

Where V is a voltage proportional to circuit voltage, and A is a voltage proportional to circuit current. The meter is connected to measure the difference between these two voltages, or 4VA. The meter, of course, is calibrated to indicate VA. The multiplier unit is sealed in a small, liquid-filled can. Usually, it never needs replacing. Should it fail, it will be replaced free of charge, if it has not been disturbed, when the instrument is returned prepaid to Fluke.

3-8. The voltage proportional to load current is obtained from a resistive shunt, which automatically provides a voltage proportional to the real power of the circuit. Since the amplifiers in the 102 are designed to maintain the phase relationship between voltage and current signals, the power measured by the 102 is real power. When measuring low power factor loads, the deflection of the meter will be small. However, meter deflection can be increased by setting switch S3 to 0.1, which decreases the amount of feedback to tubes V2 and V7, so that additional gain is available from these tubes. When switch S3 is set to 0.1, the indication of the meter must be divided by 10 to obtain the correct measurement.

3-9. Tubes V11 through V14 and associated components constitute a stabilized power supply. Tube V14 is a full-wave rectifier, the output of which is filtered by C1A, C1B, and L1. The +250 volt output is sampled by P8, R50, and R51. Tube V11 provides the reference voltage for the auxiliary supply. The voltages from P8 and V11 are applied to V12, which compares the two voltages, and controls the voltage drop across V13 to maintain a constant output voltage.

3-10. Tube V10 is a ballast tube, which stabilizes the voltage to the filaments of V2, V3, V6, V7, and V8. This results in improved stability of the ZERO W control.

3-11. It should be noted that there are several tuning capacitors in this instrument. These capacitors should not be adjusted during maintenance; to do so may result in imparing the accuracy of power measurements from 5 KC to 20 KC.

3-12. There is inherently no waveform error in the power measurements of the Model 102. The absence of waveform error is limited by the amplifiers, which, in the 102, have a flat response and introduce no phase shift between 20 to 20,000 cycles. Thus, the Model 102 will indicate accurately the power delivered by a nonsinusoidal periodic wave, as long as the fundamental frequency is above 20 cps and the highest harmonic does not appreciably exceed 20,000 cps. The power measured will be the sum of the power delivered by the individual harmonics. At frequencies above 20,000 cps, there may be error in the power measurement due to failure of the 102 amplifiers to preserve phase relation between the harmonics, or distortion of the amplitude of the harmonics. Usually, harmonics or frequencies to 40,000 cps can be measured with only a small increase in error. The error is largest at the low power factor ranges where small changes in phase angle can appreciably affect the power indication. Figure 3-1 summarizes the error contributed by several harmonics.

Per cent Harmonic	Model 102 V or A indication	Actual RMS Value
0	100	100
10% 2nd	100	100.5
20% 2nd	100-102	102
50% 2nd	100-102	112
10% 3rd	96-104	100.5
20% 3rd	94-108	102
50% 3rd	90-116	112

Figure 3-1. ERROR CONTRIBUTED BY HARMONICS

SECTION IV

MAINTENANCE

4-1. INTRODUCTION

4-2. Maintenance of the Model 102 should consist primarily of occassional cleaning and tube replacement. Preventive maintenance is discussed in paragraph 4-4. A discussion of troubleshooting and a troubleshooting chart are presented in paragraphs 4-6 and 4-7. An abbreviated calibration procedure and equipment required for calibration are presented in paragraph 4-8.

4-3. PREVENTIVE MAINTENANCE

4-4. The inside of the instrument should be cleaned as often as necessary. Compressed air can be used for this purpose, if desired.

4-5. TROUBLESHOOTING

4-6. Figure 4-1 is a table of various failures within the 102, and their probable causes. Reference to Figure 4-1 will often decrease the amount of time required for troubleshooting. It should be noted that the adjustments within the 102 should not be disturbed when trying to locate a failure. The large number of measurement combinations found on the 102 make it difficult to recalibrate with the usual facilities available.

4-7. The accuracy of the instrument should be checked after tubes or other components are replaced. In some cases, it may be necessary to try several tubes in a socket, and select the one which gives the best measurements.

SYMPTOM	POSSIBLE CAUSE	REMEDY
Pilot lamp does not illuminate	Defective line fuse	Replace fuse
	Defective transformer	Check transformer for open or short. Replace if defective.
	Defective line cord or switch	Repair or replace as necessary.
Instrument not operating. Pilot lamp on.	Defective V11, V12, V13, or V14.	Check by replacement of individual tubes.
	Defective V10	V10 should glow for only a few seconds after the 102 is turned on. If glow continues, replace V10. Also, filament voltage across pins 2 and 8 on V3 and V8 should be 6.0 to 6.4 volts.
Watt range will not zero.	Defective V3 or V8.	Replace one or both tubes, selecting tubes which will allow zeroing the panel meter with the ZERO W control near the center of its rotation.
	Defective V10	Same as above.
Oscillation of meter pointer.	Line voltage out of tolerance	Measure line voltage. Should be between 105 and 125 volts.
	Widely fluctuating line voltage.	Measure voltage fluctuations to determine if more stable line voltage is required.
	Defective V11, V12, V13, or V14	Check by replacement of individual tubes.

Figure 4-1. TROUBLESHOOTING (SHEET 1 OF 2)

SYMPTOM	POSSIBLE CAUSE	REMEDY
	P8 out of adjustment	Measure voltage of +245 volt auxiliary supply. If necessary, adjust P8 so that voltage is 245 (+2, -5) volts. P8 is located on the rear terminal board under the chassis.
No voltage indications. Ampere indications present.	Defective V1	Check by replacement.
	Defective resistors on switch S1	Measure resistance value and replace if necessary.
No current indications. Voltage indications present.	Defective V4 or V5	Check by replacement
	Defective shunt	Check shunt and shunt jacks for poor connection.
No voltage or current indications. Power indications present.	Defective V9	Check by replacement.
	Defective RE1 or RE2	Check and replace if necessary.
No power indication. Voltage and current indications present.	Defective V3 or V8	Check by replacement, selecting the tube(s) which give best balance.
	Defective V2, V6, or V7	Check by replacement.
Measurements out of calibration.	Instrument needs recalibration.	Recalibrate according to paragraph 4-8.

Figure 4-1. TROUBLESHOOTING (SHEET 2 OF 2)

4-8. CALIBRATION

a. Connect a 0.006 ampere shunt to the 102.
b. Set the VOLTS switch to 6 volts.
c. Set the POWER FACTOR switch to 1.
d. Connect a 1,000 ohm, 1%, 1/2 watt, resistor between terminals H and L. output
e. Set power switch to ON.
f. Set VAW® switch to W.
g. Rotate the ZERO W control to zero the panel meter.
h. Connect a thermo-ammeter (Weston, 0 to 10 ma., or equivalent) to the H terminal. Connect a sine wave oscillator (Hewelett Packard Model 200AB, or equivalent) between the other terminal of the thermo-ammeter and the G terminal. Set the oscillator to 1,000 cycles per second.
i. Adjust the oscillator output so that the thermo-ammeter indicates 6 milliamperes. Load voltage will be 6 volts.
j. Set VAW® switch to V, and adjust P2 so that the panel meter indicates full scale.
k. Set VAW® switch to A, and adjust P1 so that the panel meter indicates full scale.
l. Set VAW® switch to W, and adjust P4 so that the panel meter indicates full scale.
m. Set the power switch to off.
n. Disconnect the thermo-ammeter and the 1,000 ohm resistor. Connect the oscillator between terminals H and G.
o. Connect a series combination of a 92.5 ohm, 10%, 1/2 watt resistor and an 0.25 uf mica capacitor between terminals H and L. The capacitor must be mica because of low leakage.
p. Set the power switch to ON.
q. Adjust the oscillator output so that the panel meter of the 102 indicates full scale as nearly as possible.
r. Set the VAW® switch to W, and adjust P6 so that the panel meter indicates full scale.
s. Note that the preceeding steps are adequate adjustments for most occassions. The Model 102 has 252 possible measurement combinations. Because of the large number of measurement combinations, it is recommended that, if extensive repairs have been made, of if extensive recalibration is required, the 102 be returned to the factory.

EQUIPMENT	REQUIREMENTS
Current shunt for 102	0.006 ampere rating
Thermo-ammeter, Weston or equivalent	Capable of measuring 0 to 10 milliamperes
Oscillator, Hewelett Packard Model 200AB, or equivalent	Must be capable of providing 6 milliamperes at 1000 cps with variable amplitude.
Resistor	92.5 ohms, 10%, 1/2W 1K, 1%, 1/2W
Capacitor	0.25 uf, mica.

Figure 4-2. EQUIPMENT REQUIRED FOR CALIBRATION

SECTION V

LIST OF REPLACEABLE PARTS

5-1. INTRODUCTION

5-2. The list on the following pages describes all normally replaceable parts of the Model 102. Parts are identified on the list and on corresponding illustrations by reference designations from the schematic diagram. Those parts (mechanical) which have no reference designation are shown on the illustrations by Fluke stock number.

5-3. HOW TO OBTAIN PARTS:

5-4. Most parts are standard components and can be obtained locally. All parts manufactured, altered, or designed by Fluke are designated by an asterisk preceeding the Fluke stock number. All structual parts and special parts should be ordered from your local Fluke representative or from the factory.

5-5. When ordering parts, always include the following:
a. Reference designation, description, and Fluke stock number.
b. Instrument model and serial number.

5-6. Most structural parts are not listed in the following chart. To order these, give complete description, function and location of part.

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
C1A, C1B, C2A, C2B, C3A, C3B, C4A, C4B	Capacitor, electrolytic, dual, 20-20 uf, -10/+50%, 450V	1502-105064	
C5, C6	Capacitor, electrolytic, 500 uf, -10/+100%, 25V	1502-105031	
C7	Capacitor, electrolytic, 2000 uf, -10/+100%, 5V	1502-105072	
C8	Capacitor, electrolytic, 200 uf, -10/+75%, 6V	1502-105189	
C10	Capacitor, paper, 0.22 uf, 20%, 400V	1506-105304	
C11	Capacitor, paper, 0.1 uf, 20%, 400V	1506-105312	
C12	Capacitor, electrolytic, 20 uf, -10/+100%, 250V	1502-105817	
C13	Capacitor, paper, 0.1 uf, 20%, 400V	1506-105312	
C14	Capacitor, paper, 0.22 uf, 20%, 400V	1506-105304	
C15	Capacitor, paper, 0.1 uf, 20%, 400V	1506-105312	
C16	Capacitor, paper, 0.22 uf, 20%, 400V	1506-105304	
C17	Capacitor, plastic, 0.22 uf, 10%, 400V	1507-105452	
C18	Capacitor, electrolytic, 40 uf, -10/+50%, 450V	1502-105056	
C19	Capacitor, paper, 0.1 uf, 20%, 400V	1506-105312	

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
C20	Capacitor, paper, 1 uf, -10/+30%, 400V	1506-105361	
C21	Capacitor, paper, 0.1 uf, 20%, 400V	1506-105312	
C22	Capacitor, paper, 0.22 uf, 20%, 400V	1506-105304	
C23	Capacitor, paper, 0.1 uf, 20%, 400V	1506-105312	
C24A, C24B	Capacitor, paper, 1 uf, -10/+30%, 400V	1506-105361	
C25	Capacitor, paper, 0.1 uf, 20%, 400V	1506-105312	
C26, C27	Capacitor, plastic, 0.22 uf, 10%, 400V	1507-105452	
C28	Capacitor, electrolytic, 16 uf, -10/+15%, 450V	1502-105049	
C40	Capacitor, variable ceramic, 7-35 uuf, 500V	1501-105627	
C41	Capacitor, variable, ceramic, 4-30 uuf, 500V	1509-105015	
C42	Capacitor, ceramic, 3.3 uuf, 0.15%, 500V	1501-105577	
C43	Capacitor, ceramic, 39 uuf, 2%, 600V	1501-105627	
C44	Capacitor, ceramic, 100 uuf, 10%, 500V	1501-105593	
C45	Capacitor, ceramic, 82 uuf, 10%, 500V	1501-105585	
C46, C47, C48, C49, C50	Capacitor, variable, ceramic, 7-35uuf, 500V	1509-105015	
C51	Capacitor, ceramic, 39 uuf, 2%, 600V	1501-105627	
C52	Capacitor, ceramic, 82 uuf, 10%, 500V	1501-105585	
C53	Capacitor, ceramic, 220 uuf, -20/+10%, 500V	1501-105528	
C54	Capacitor, ceramic, 82 uuf, 10%, 500V	1501-105585	
C55	Capacitor, variable, mica (not illus.) 170-780 uuf, 175V	1509-106245	
C56	Capacitor, ceramic, 82 uuf, 10%, 500V	1501-105585	
F1	Fuse, (not illustrated)	5101-109199	
	Lamp	3901-100305	
L1	Choke, filter, 7h, 140 ma	1801-115253	
M1	Meter, 500 ua	M2	C
	Meter, 500 ua	2901-111450	D
P1, P2	Resistor, variable, wirewound, 1K, 10%, 2W	4702-111716	
P3	Resistor, variable, wirewound, 2K, 10%, 2W	4702-112466	
P4	Resistor, variable, wirewound, 300Ω, 10%, 2W	4702-111740	
P5	Resistor, variable, wirewound, 5K, 10%, 2W	4702-111591	
P6	Resistor, variable, wirewound, 300Ω, 10%, 2W	4702-111740	

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
P8	Resistor, variable, wirewound, 5K, 10%, 2W	4702-111591	
P9	Resistor, variable, wirewound, 500Ω, 10%, 1-1/4W	4702-111799	
R3	Resistor, composition, 22K, 10%, 1W	4704-109470	
R4	Resistor, composition, 10K, 10%, 1W	4704-109389	
R5	Resistor, composition (not illus.) 10M, 10%, 1/2W	4704-108142	
R6	Resistor, composition, 22K, 10%, 1W	4704-109470	
R7	Resistor, composition, 220K, 10%, 1/2W	4704-108217	
R8	Resistor, composition, 100K, 10%, 1W	4704-109397	
R10	Resistor, composition, 33K, 10%, 1W	4704-109538	
R11	Resistor, composition, 470K, 10%, 1/2W	4704-108290	
R12	Resistor, composition, 150K, 10%, 1/2W	4704-108167	
R13	Resistor, composition, 18K, 10%, 1/2W	4704-108183	
R14	Resistor, composition, 1.5M, 10%, 1/2W	4704-108175	
R15	Resistor, deposited carbon, 75Ω, 1%, 1/2W	4703-107045	
R17	Resistor, composition, 33K, 10%, 1W	4704-109538	
R18	Resistor, composition, 100K, 10%, 1W	4704-109397	
R19	Resistor, composition, 220K, 10%, 1/2W	4704-108217	
R20	Resistor, composition, 22K, 10%, 1W	4704-109470	
R21	Resistor, composition, 100K, 10%, 1W	4704-109397	
R22	Resistor, deposited carbon, 10K, 1%, 1/2W	4703-107128	
R23	Resistor, composition, 220K, 10%, 1/2W	4704-108217	
R24	Resistor, composition (not illus.) 10K, 10%, 1W	4704-109389	
R25	Resistor, composition, 100K, 10%, 1W	4704-109397	
R27	Resistor, composition, 220K, 10%, 1/2W	4704-108217	
R28	Resistor, composition, 22K, 10%, 1W	4704-109470	
R29	Resistor, composition, 100K, 10%, 1W	4704-109397	
R30	Resistor, composition, 27K, 10%, 1W	4704-109504	B
	Resistor, composition 33K, 10%, 1W	4704-109538	A
R31	Resistor, composition, 470K, 10%, 1/2W	4704-108290	
R32	Resistor, composition, 150K, 10%, 1/2W	4704-108167	
R33	Resistor, composition, 18K, 10%, 1/2W	4704-108183	

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
R34, R35	Resistor, composition, 18K, 10%, 1W	4704-109447	
R36	Resistor, deposited carbon, 3.89K, 1%, 1/2W	4703-107268	
R37	Resistor, composition, 470K, 10%, 1/2W	4704-108290	
R38, R39	Resistor, composition, 560Ω, 10%, 1/2W	4704-108316	
R40	Resistor, composition, 1.5K, 10%, 1W	4704-109413	
R41	Resistor, composition, 15Ω, 10%, 1W	4704-109405	
R42	Resistor, composition (not illus.) 82K, 10%, 1W	4704-109637	
R43	Resistor, composition, 33K, 10%, 1W	4704-109538	
R44	Resistor, composition, 470K, 10%, 1/2W	4704-108290	
R45	Resistor, composition, 12K, 10%, 2W	4704-110155	
R46	Resistor, composition, 330K, 10%, 1W	4704-109546	
R47	Resistor, composition, 270K, 10%, 1W	4704-109512	
R48, R49	Resistor, composition (R48 not illus.) 470K, 10%, 1/2W	4704-108290	
R50	Resistor, wirewound, 18K, 10%, 5W	4706-112839	
R51	Resistor, composition, 4.7K, 10%, 1W	4704-109587	
R54, R55	Resistor, composition, 5.6K, 10%, 1/2W	*4704-108324	
R56	Resistor, wirewound, 150Ω, 5%, 10W	4706-112334	
R100	Resistor, deposited carbon, 900K, 1%, 1/2W	4703-107391	
R101	Resistor, deposited carbon, 90K, 1%, 1/2W	4703-107292	
R102	Resistor, deposited carbon 10K, 1%, 1/2W	4703-107128	
R103	Resistor, deposited carbon, 1.5K, 1%, 1/2W	4703-107094	
R104	Resistor, deposited carbon, 5.44K, 1%, 1/2W	4703-107235	
R105	Resistor, deposited carbon, 1.845K, 1%, 1/2W	4703-107102	
R106	Resistor, deposited carbon, 135Ω, 1%, 1/2W	4703-107052	
R107, R108	Resistor, deposited carbon, 50K, 1%, 1/2W	4703-107177	
R109	Resistor, deposited carbon, 40K, 1%, 1/2W	4703-107151	
R110	Resistor, deposited carbon, 135K, 1%, 1/2W	4703-107201	
R111, R112	Resistor, deposited carbon, 200Ω, 1%, 1/2W	4703-107060	
R113	Resistor, deposited carbon, 135K, 1%, 1/2W	4703-107201	
R114	Resistor, deposited carbon, 40K, 1%, 1/2W	4703-107151	
R115, R116	Resistor, deposited carbon, 50K, 1%, 1/2W	4703-107177	

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
R117	Resistor, deposited carbon, 52.14K, 1%, 1/2W	4703-107284	
R118	Resistor, deposited carbon, 50K, 1%, 1/2W	4703-107177	
RE1, RE2	Diode, germanium, 50 PIV, 25 ma, Type 1N51	4802-100354	
	S-Can Assembly NOTE: If the S-Can Assembly becomes defective, it cannot be repaired, but must be replaced.	117838 (102-409)	
S1	Switch, rotary, 4 pole, 11 position	5105-114645	
S2, S3	Switch, rotary, 3 pole, 3 position	5105-114652	
S4	Switch, toggle, SPST, 230V, 3 Amp	5106-114850	
T1	Transformer, power	5902-115279	
V1	Electron tube, dual triode, Type 6SN7	5701-116491	
V2	Electron tube, pentode, Type 6AC7	5701-116384	
V3	Electron tube, pentode, Type 6V6	5701-116517	
V4	Electron tube, pentode, Type 6SJ7	5701-116509	
V5, V6, V7	Electron tube, pentode, Type 6AC7	5701-116384	
V8	Electron tube, pentode, Type 6V6	5701-116517	
V9	Electron tube, dual triode, Type 6SN7	5701-116491	
V10	Tube, ballast, Type 22-4	5701-116004	
V11	Tube, voltage regulator, Type OD3	5701-115907	
V12	Electron tube, dual triode, Type 6SL7	5701-116483	
V13	Electron tube, dual triode, Type 6080	5701-116376	
V14	Electron tube, rectifier, Type 5Y3	5701-116368	
	Handle	2404-103275	
	Rubber Support	2819-101253	
	Knob	2405-101295	
	Knob	2405-101311	
	Fuse Holder	2102-100107	
	Lamp	3903-100115	
	Line Cord	6005-102822	
	Bushing, strain relief	2502-101162	
	Input Jacks	2109-100271	

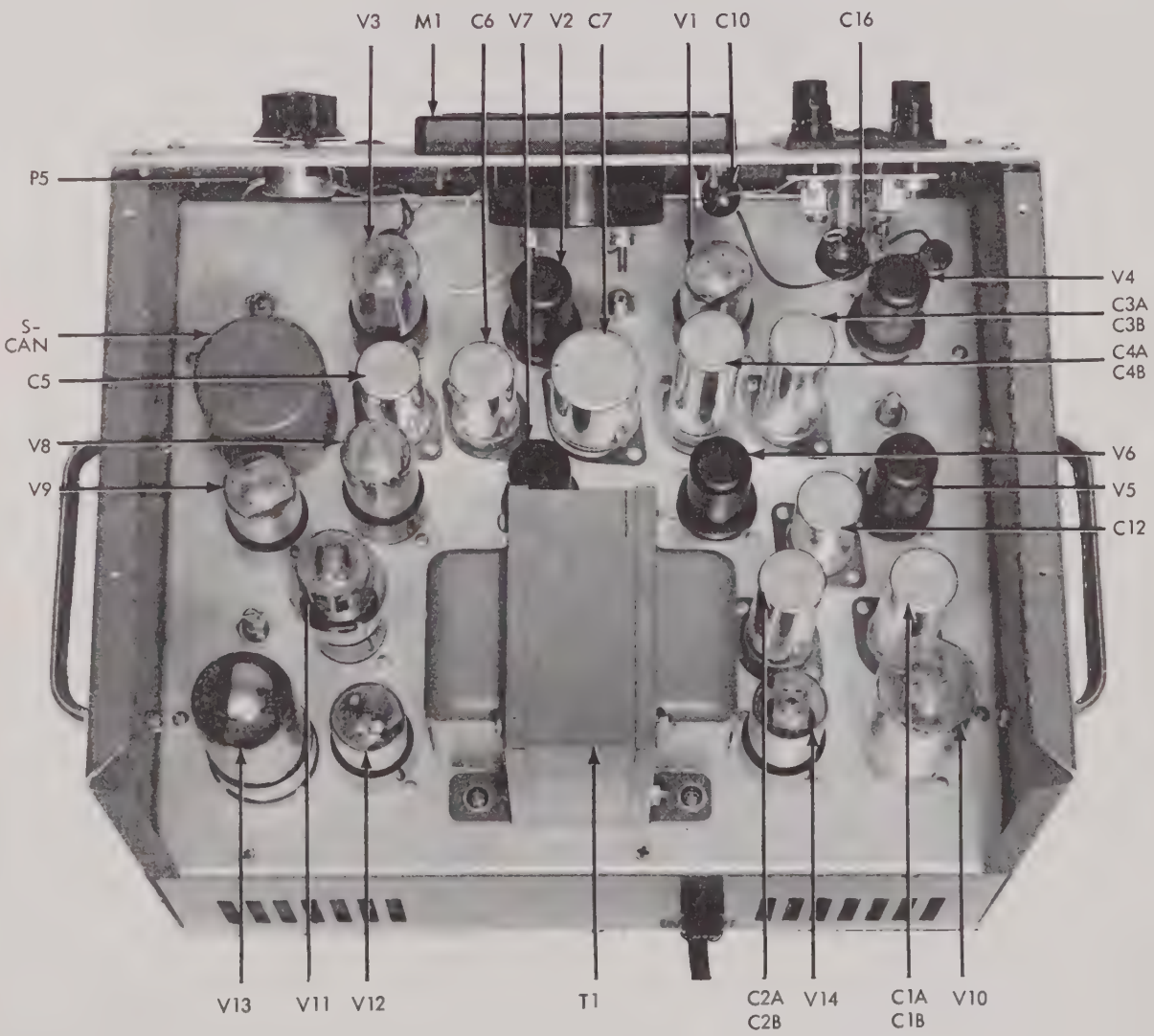


Figure 5-1. FINAL ASSEMBLY (Sheet 1 of 4)

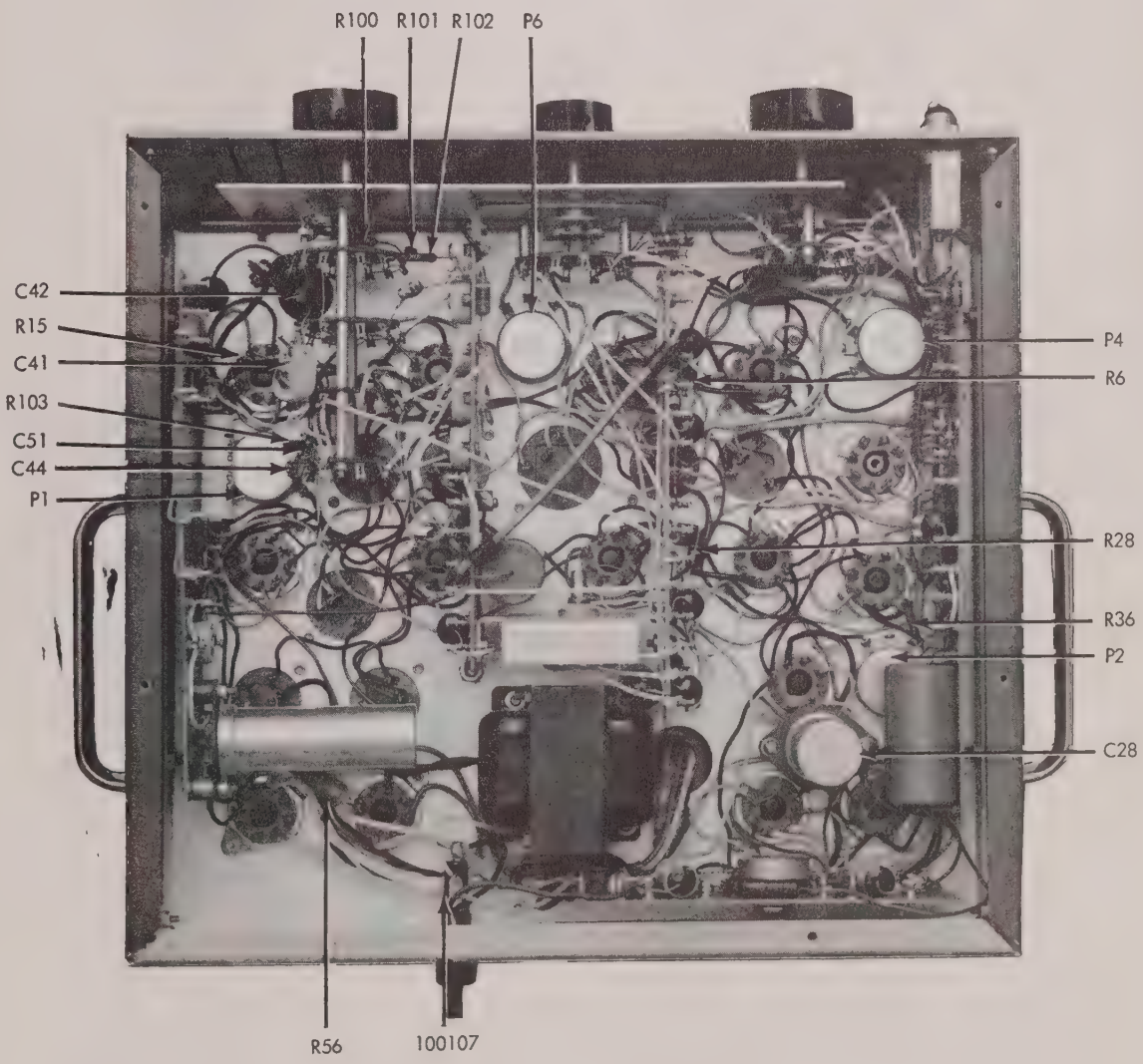


Figure 5-1. FINAL ASSEMBLY (Sheet 2 of 4)

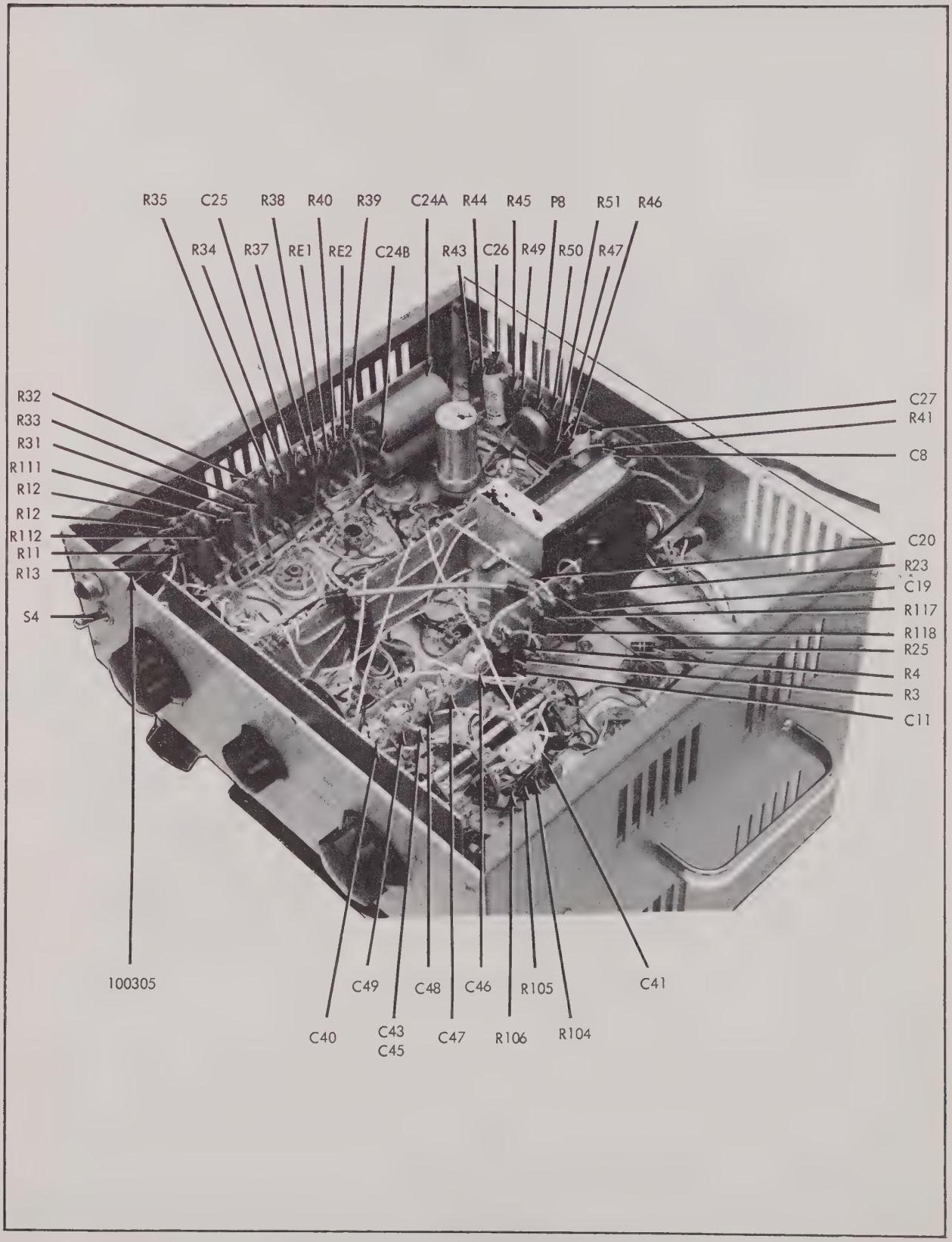


Figure 5-1. FINAL ASSEMBLY (Sheet 3 of 4)

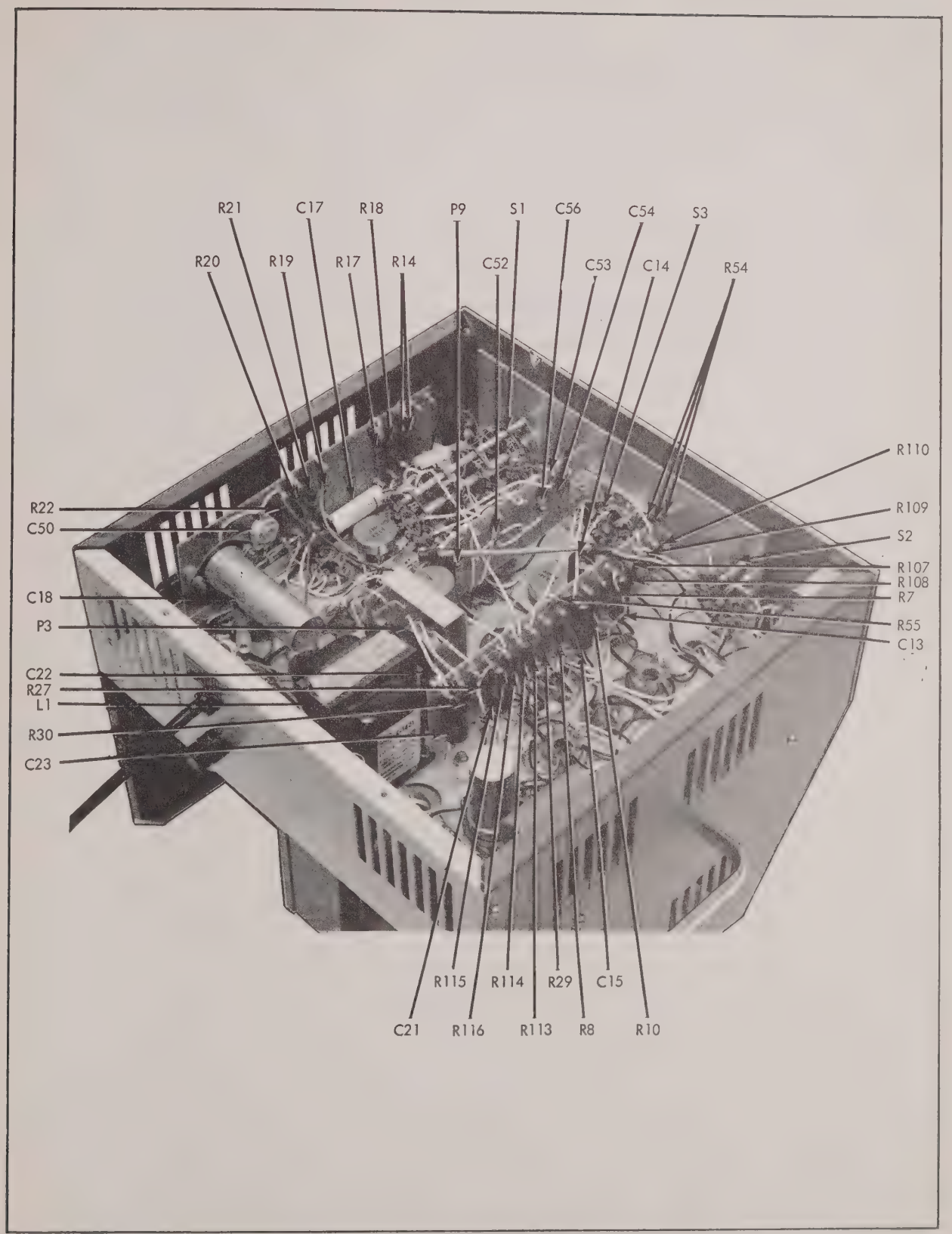


Figure 5-1. FINAL ASSEMBLY (Sheet 4 of 4)

5-7. USE CODE EFFECTIVITY

5-8. The following use codes allow the customer to determine the effectivity of all replaceable parts. All parts having no code were used on all instruments serial number 123 and ON.

USE CODE	EFFECTIVITY
No Code	Model 102, serial number 123 and on.
A	Model 102, serial number 123 through 815.
B	Model 102, serial number 816 and on.
C	Model 102, serial number 123 through 756.
D	Model 102, serial number 757 and on.

APPENDIX A

FEDERAL SUPPLY CODE FOR MANUFACTURERS

A-1. CODE TO NAME

A-2. The following five-digit code numbers are listed in numerical sequence along with the manufacturer's name and address to which the code has been assigned. The Federal Supply Code has been taken from Cataloging Handbook H 4-2, Code to Name.

00213	Sage Electronics Corp. Rochester, New York
00327	Welwyn International, Inc. Westlake, Ohio
00656	Aerovox Corp. New Bedford, Massachusetts
00779	AMP Inc. Harrisberg, Pennsylvania
01121	Allen-Bradley Co. Milwaukee, Wisconsin
01281	TRW Semiconductors Lawndale, California
01295	Texas Instruments, Inc. Semiconductor Components Div. Dallas, Texas
01686	RCL Electronics Inc. Manchester, New Hampshire
01730	Deleted
01884	Dearborn Electronics Inc. Orlando, Florida
02114	Ferroxcube Corp. Saugerties, New York
02606	Replaced by 15801
02660	Amphenol-Borg Elect. Corp. Broadview, Illinois
02799	Arco Capacitors, Inc. Los Angeles, California
03614	Replaced by 71400
03651	Replaced by 44655
03797	Eldema Corp. Compton, California
03877	Transitron Electronic Corp. Wakefield, Massachusetts
03888	Pyrofilm Resistor Co., Inc. Cedar Knolls, New Jersey
03911	Clairex Corp. New York, New York
03980	Murhead Instruments, Inc. Mountainside, New Jersey
04009	Arrow Hart and Hegemen Electronic Company Hartford, Connecticut
04062	Replaced by 72136
04202	Replaced by 81312
04217	Essex Wire Corp Wire & Cable Div. Anaheim, California
04221	Aemco Div. of Midtex Inc. Mankato, Minnesota
04645	Replaced by 75376
04713	Motorola Semiconductor Products Inc. Phoenix, Arizona
05082	Replaced by 94154
05236	Jonathan Mfg. Co. Fullerton, California
05277	Westinghouse Electric Corp. Semiconductor Dept. Youngwood, Pennsylvania
05278	Replaced by 43543
05397	Union Carbide Corp. Electronics Div. Cleveland, Ohio
05571	Sprague Electric Co Pacific Div. Los Angeles, California
05704	Alac, Inc. Glendale, California
05820	Wakefield Engineering Ind. Wakefield, Massachusetts
06001	General Electric Company Capacitor Department Irmo, South Carolina
06136	Replaced by 63743
06473	Amphenol Space & Missile Sys. Chatsworth, California
06555	Beede Electrical Instrument Co. Penacook, New Hampshire
06739	Electron Corp. Littletown, Colorado
06743	Clevite Corp. Cleveland, Ohio
06751	Semcor Div. Components Phoenix, Arizona
06860	Gould National Batteries Inc. City of Industry, California
06980	Eitel-McCullough, Inc. San Carlos, California
07115	Replaced by 14674
07138	Westinghouse Electric Corp Electronic Tube Div. Elmira, New York
07263	Fairchild Semiconductor Div. of Fairchild Camera & Instrument Corp. Mountain View, California
07344	Bircher Co., Inc. Rochester, New York
07792	Lerma Engineering Corp Northampton, Massachusetts
07910	Continental Device Corp. Hawthorne, California
08530	Reliance Mica Corp. Brooklyn, New York
08792	CBS Electronics Semiconductor Operations-Div. of CBS Inc. Lowell, Massachusetts
08806	General Electric Co. Miniature Lamp Dept. Cleveland, Ohio
08863	Nylomatic Corp. Norrisville, Pennsylvania
08988	Skottie Electronics Inc. Archbald, Pennsylvania
09922	Burndy Corp. Norwalk, Connecticut
11237	Chicago Telephone of Calif. Inc. South Pasadena, California
11358	CBS Electronics Div. of CBS Inc. Newburyport, Massachusetts
11403	Best Products Co. Chicago, Illinois
11503	Keystone Mfg Div. of Avis Industrial Corp. Warren, Michigan
12014	Chicago Rivet & Machine Co. Bellwood, Illinois
12040	National Semiconductor Corp. Danburry, Connecticut
12060	Diodes, Inc. Chatsworth, California
12136	Philadelphia Handle Co. Camden, New Jersey
12323	Presin Co., Inc. Shelton, Connecticut
12327	Freeway Washer & Stamping Co. Cleveland, Ohio
12400	Replaced by 75042
12617	Hamlin Inc. Lake Mills, Wisconsin
12697	Clarostat Mfg. Co. Dover, New Hampshire
12749	James Electronics Chicago, Illinois

12856	Micrometals Sierra Madre, California
12954	Dickson Electronics Corp. Scottsdale, Arizona
13606	Sprague Electric Co. Transistor Div. Concord, New Hampshire
13839	Replaced by 23732
14099	Semtech Corp. Newbury Park, California
14193	California Resistor Corp. Santa Monica, California
14298	American Components, Inc. Conshohocken, Pennsylvania
14655	Cornell-Dubilier Electronics Newark, New Jersey
14674	Corning Glass Works Corning, New York
14752	Electro Cube Inc. San Gabriel, California
14869	Replaced by 96853
15636	Elec-Trol Inc. Northridge, California
15801	Fenwal Electronics Inc. Framingham, Massachusetts
15818	Amelco Semiconductor Div. of Teledyne Inc. Mountain View, California
15849	Useco, Inc. Mt. Vernon, New York
15909	Replaced by 17870
16332	Replaced by 28478
16473	Cambridge Scientific Ind. Inc. Cambridge, Maryland
16742	Paramount Plastics Downey, California
16758	Delco Radio Div. of General Motors Kokomo, Indiana
17069	Circuit Structures Lab. Upland, California
17856	Siliconix, Inc. Sunnyvale, California
17870	Daven-Div. of Thomas A. Edison Ind. --McGraw-Edison Co. Manchester, New Hampshire
18083	Deleted
18178	Vactec Inc. Maryland Heights, Missouri
18736	Voltronics Corp. Hanover, New Jersey
19429	Montronics, Inc. Seattle, Washington
19451	Perine Machinery & Supply Co. Seattle, Washington
19701	Electra Mfg. Co. Independence, Kansas
20584	Enochs Mfg. Co. Indianapolis, Indiana
22767	ITT Semiconductors Div. of ITT Palo Alto, California
23732	Tracor Rockville, Maryland
24248	Southco Div. of South Chester Corp. Lester, Pennsylvania
24655	General Radio Co. West Concord, Massachusetts
25403	Amperex Electronic Corp Semiconductor & Receiving Tube Division Slatersville, Rhode Island
28478	Deltrol Controls Corp. Milwaukee, Wisconsin
28520	Heyman Mfg. Co. Kenilworth, New Jersey
30323	Illinois Tool Works Inc. Chicago, Illinois
33173	General Electric Co. Tube Dept. Owensboro, Kentucky
37942	Mallory, P. R., & Co., Inc. Indianapolis, Indiana
38315	Honeywell Inc. Precision Meter Div. Manchester, New Hampshire
42498	National Company Melrose, Massachusetts
43543	Nytronics Inc. Transformer Co. Div. Alpha, New Jersey
44655	Ohmite Mfg. Co. Skokie, Illinois
49671	Radio Corp. of America New York, New York
49956	Raytheon Company Lexington, Maine
53021	Sangamo Electric Co. Springfield, Illinois
55026	Simpson Electric Company Chicago, Illinois
56289	Sprague Electric Co. North Adams, Massachusetts
58474	Superior Electric Co. Bristol, Connecticut
60399	Torrington Mfg. Co. Torrington, Connecticut
62460	Deleted
63743	Ward Leonard Electric Co. Mount Vernon, New York
64834	West Mfg. Co. San Francisco, California
65092	Weston Instruments Inc. Newark, New Jersey
66150	Winslow Tele-Tronics Inc. Asbury Park, New Jersey
70563	Amperite Company Union City, New Jersey
70903	Belden Mfg. Co. Chicago, Illinois
71002	Birnbach Radio Co., Inc. New York, New York
71400	Bussmann Mfg. Div. of McGraw-Edison Co. St. Louis, Missouri
71450	CTS Corp. Elkhart, Indiana
71468	ITT Cannon Electric Inc. Los Angeles, California
71482	Clare, C P & Co. Chicago, Illinois
71590	Centralab Div. of Globe Union Inc. Milwaukee, Wisconsin
71707	Coto Coil Co., Inc. Providence, Rhode Island
71744	Chicago Miniature Lamp Works Chicago, Illinois
71785	Cinch Mfg. Co. & Howard B. Jones Div. Chicago, Illinois
72005	Driver, Wilber B., Co. Newark, New Jersey
72092	Replaced by 06980
72136	Electro Motive Mfg. Co. Willimantic, Connecticut
72259	Nytronics Inc. Berkeley Heights, New Jersey
72354	Deleted
72619	Dialight Corp Brooklyn, New York
72653	G. C. Electronics Rockford, Illinois
72665	Replaced by 90303
72794	Dzus Fastener Co., Inc. West Islip, New York
72928	Gudeman Co. Chicago, Illinois
72982	Erie Tech. Products Inc. Erie, Pennsylvania
73138	Beckman Instruments Inc. Helipot Division Fullerton, California
73293	Hughes Aircraft Co. Electron Dynamics Div. Newport Beach, California
73445	Amperex Electronic Corp. Hicksville, New York
73559	Carling Electric Inc. Hartford, Connecticut
73586	Circle F Industries Trenton, New Jersey
73734	Federal Screw Products, Inc. Chicago, Illinois
73743	Fischer Special Mfg. Co. Cincinnati, Ohio
73899	JFD Electronics Co. Brooklyn, New York
73949	Guardian Electric Mfg. Co. Chicago, Illinois
74199	Quam Nichols Co. Chicago, Illinois
74217	Radio Switch Corp. Marlboro, New Jersey
74276	Signalite Inc. Neptune, New Jersey
74306	Piezo Crystal Co. Carlisle, Pennsylvania
74542	Hoyt Elect. Instr. Works Penacook, New Hampshire
74970	Johnson, E. F., Co. Waseca, Minnesota
75042	IRC Inc. Philadelphia, Pennsylvania
75376	Kurz-Kasch, Inc. Dayton, Ohio
75382	Kulka Electric Corp. Mt. Vernon, New York
75915	Littlefuse Inc. Des Plaines, Illinois
76854	Oak Mfg. Co. Crystal Lake, Illinois
77342	Potter & Brumfield Div. of Amer. Machine & Foundry Princeton, Indiana
77969	Rubbercraft Corp. of Calif. LTD. Torrance, California

78189 Shakeproof
Div. of Illinois Tool Works
Elgin, Illinois

78277 Sigma Instruments, Inc.
South Braintree, Massachusetts

78488 Stackpole Carbon Co.
St. Marys, Pennsylvania

78553 Tinnerman Products
Cleveland, Ohio

79136 Waldes Kohinoor Inc.
Long Island City, New York

79497 Western Rubber Company
Goshen, Indiana

79963 Zierick Mfg. Corp.
New Rochelle, New York

80031 Mepco
Div. of Sessions Clock Co.
Morristown, New Jersey

80145 API Instruments Co.
Chesterland, Ohio

80183 Sprague Products
North Adams, Massachusetts

80294 Bourns Inc.
Riverside, California

80583 Hammarlund Co., Inc.
Mars Hill, North Carolina

80640 Stevens, Arnold Inc.
Boston, Massachusetts

81073 Grayhill Inc.
La Grange, Illinois

81312 Winchester Electronics
Div. of Litton Industries
Oakville, Connecticut

81439 Therm-O-Disc Inc.
Mansfield, Ohio

81483 International Rectifier Corp.
El Segundo, California

81590 Korry Mfg. Co.
Seattle, Washington

82376 Deleted

82389 Switchcraft Inc.
Chicago, Illinois

82415 Price Electric Corp.
Frederick, Maryland

82872 Roanwell Corp.
New York, New York

82877 Rotron Mfg. Co., Inc.
Woodstock, New York

82879 ITT Wire & Cable Div.
Pawtucket, Rhode Island

83003 Varo Inc.
Garland, Texas

83298 Bendix Corp.
Electric Power Division
Eatontown, New Jersey

83330 Smith, Herman H., Inc.
Brooklyn, New York

83478 Rubbercraft Corp. of America
New Haven, Connecticut

83594 Burroughs Corp.
Electronic Components Div.
Plainfield, New Jersey

83740 Union Carbide Corp.
Consumer Products Div.
New York, New York

84171 Arco Electronics, Inc.
Great Neck, New York

84411 TRW
Ogallala, Nebraska

86577 Precision Metal Products
Stoneham, Massachusetts

86684 Radio Corp. of America
Electronic Components & Devices
Harrison, New Jersey

86689 Deleted

87034 Marco-Oak Inc.
Anaheim, California

88419 Use 14655

88690 Replaced by 04217

89536 Fluke, John Mfg. Co., Inc.
Seattle, Washington

89730 Replaced by 08806

90201 Mallory Capacitor Co.
Indianapolis, Indiana

90215 Best Stamp & Mfg. Co.
Kansas City, Missouri

90211 Square D Co.
Chicago, Illinois

90303 Mallory Battery Co.
Tarrytown, New York

91293 Johanson Mfg. Co.
Boonton, New Jersey

91407 Replaced by 58474

91637 Dale Electronics Inc.
Columbus, Nebraska

91662 Elco Corp.
Willow Grove, Pennsylvania

91737 Gremar Mfg. Co., Inc.
Wakefield, Massachusetts

91802 Industrial Devices, Inc.
Edgewater, New Jersey

91836 King's Electronics
Tuckahoe, New York

91929 Honeywell Inc.
Micro Switch Div.
Freeport, Illinois

91934 Miller Electric Co., Inc.
Pawtucket, Rhode Island

93332 Sylvania Electric Products
Semiconductor Products Div.
Woburn, Massachusetts

94145 Replaced by 49956

94154 Tung-Sol
Div. of Wagner Electric Corp.
Newark, New Jersey

95146 Alco Electronics Products Inc.
Lawrence, Massachusetts

95263 Leecraft Mfg. Co.
Long Island City, New York

95264 Replaced by 98278

95275 Vitramon Inc.
Bridgeport, Connecticut

95303 Radio Corp. of America
Solid State & Receiving Tube Div.
Cincinnati, Ohio

95354 Methode Mfg. Corp.
Rolling Meadows, Illinois

95712 Dage Electric Co., Inc.
Franklin, Indiana

95987 Weckesser Co., Inc.
Chicago, Illinois

96733 San Fernando Electric Mfg. Co.
San Fernando, California

96853 Rustrak Instrument Co.
Manchester, New Hampshire

96881 Thomson Industries, Inc.
Manhasset, New York

97540 Master Mobile Mounts
Div. of Whitehall Electronics Corp.
Los Angeles, California

97913 Industrial Electronic Hdware Corp.
New York, New York

97945 White, S. S. Co.
Plastics Div.
New York, New York

97966 Replaced by 11358

98094 Replaced by 49956

98278 Microdot Inc.
Pasadena, California

98291 Sealectro Corp.
Conhex Div
Mamaroneck, New York

98388 Accurate Rubber & Plastics
Culver City, California

98743 Replaced by 12749

98925 Deleted

99120 Plastic Capacitors, Inc.
Chicago, Illinois

99217 Southern Electronics Corp.
Burbank, California

99515 Marshall Industries
Capacitor Div.
Monrovia, California

Revised August 1, 1968
Using H4-1 and H4-2
Dated June , 1968

WARRANTY

The JOHN FLUKE MFG. CO., INC. warrants each instrument manufactured by them to be free from defects in material and workmanship. Their obligation under this Warranty is limited to servicing or adjusting an instrument returned to the factory for that purpose, and to making good at the factory any part or parts thereof; except tubes, fuses, choppers and batteries, which shall, within one year after making delivery to the original purchaser, be returned by the original purchaser with transportation charges prepaid, and which upon their examination shall disclose to their satisfaction to have been thus defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at a nominal cost. In this case, an estimate will be submitted before work is started, if requested.

If any fault develops, the following steps should be taken.

1. Notify the John Fluke Mfg. Co., Inc., giving full details of the difficulty, and include the Model number, type number, and serial number. On receipt of this information, service data or shipping instructions will be forwarded to you.

2. On receipt of the shipping instructions, forward the instrument prepaid, and repairs will be made at the factory. If requested, an estimate of the charges will be made before the work begins, provided the instrument is not covered by the Warranty.

SHIPPING

All shipments of John Fluke Mfg. Co., Inc. instruments should be made via Railway Express prepaid. The instrument should be shipped in the original packing carton; or if it is not available, use any suitable container that is rigid. If a substitute container is used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock-absorbing material.

CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be thoroughly inspected immediately upon receipt. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to John Fluke Mfg. Co., Inc. Upon receipt of this report you will be advised of the disposition of the equipment for repair or replacement. Include the model number, type number, and serial number when referring to this instrument for any reason.

The John Fluke Mfg. Co., Inc. will be happy to answer all application questions which will enhance your use of this instrument. Please address your requests to:

JOHN FLUKE MFG. CO., INC., P. O. BOX 7428, SEATTLE 33, WASHINGTON

Sales and Service Representatives

ALABAMA

HUNTSVILLE

BCS Associates, Inc.
2317 Bob Wallace Ave. S.W.
Tel. (205) 534-1648

ALASKA

SEATTLE

Instrument Specialists, Inc.
5950 Sixth Ave. South
Suite 106
Seattle, Washington
Tel. (206) 767-4260

ARIZONA

PHOENIX

Barnhill Associates
4900 E. Indian School Road
Tel. (602) 959-2115

CALIFORNIA

LOS ANGELES

Instrument Specialists, Inc.
2870 Los Feliz Place
Tel. (213) 665-5181

SAN FRANCISCO

Instrument Specialists, Inc.
2359 De La Cruz
Santa Clara, California
Tel. (408) 244-1505

COLORADO

DENVER

Barnhill Associates
1170 S. Sheridan Blvd.
Tel (303) 934-5505

CONNECTICUT

HARTFORD

Instrument Representatives, Inc.
P.O. Box 165
Glastonbury, Connecticut
Tel. (203) 633-0777

FLORIDA

ORLANDO

BCS Associates, Inc.
940 N. Fern Creek Ave.
Tel. (305) 425-2764

HAWAII

HONOLULU

Industrial Electronics, Inc.
646 Queen Street
Tel. (808) 506-095

ILLINOIS

CHICAGO

Cozzens & Cudahy, Inc.
9501 W. Devon Ave.
Rosemont, Illinois
Tel. (312) 825-1144

INDIANA

INDIANAPOLIS

Cozzens & Cudahy, Inc.
44 Kirk Drive
Tel. (317) 244-2456

LOUISIANA

NEW ORLEANS

BCS Associates, Inc.
P.O. Box 7371
Metairie, Louisiana
Tel. (504) 888-2266

MARYLAND

BALTIMORE

Electronic Marketing Assoc.
11501 Huff Court
Kensington, Maryland
Tel. (301) 744-7700

MASSACHUSETTS

BOSTON

Instrument Representatives, Inc.
1046 Massachusetts Avenue
Arlington, Massachusetts
Tel. (617) 646-1034

MICHIGAN

DETROIT

Technitron, Inc.
13657 Grand River Ave.
Tel. (313) 838-7324

MINNESOTA

MINNEAPOLIS

Cozzens & Cudahy, Inc.
7710 Computer Ave.
Tel. (612) 920-1022

MISSOURI

ST. LOUIS

Cozzens & Cudahy, Inc.
10534 Natural Bridge Road
Edmundson, Missouri
Tel. (314) 423-1234

NEW JERSEY

NEWARK

SBM Associates, Inc.
1519 Stuyvesant Avenue
Union, New Jersey
Tel. (201) 687-8737

NEW MEXICO

ALBUQUERQUE

Barnhill Associates
827 Pennsylvania Ave.
Tel. (505) 265-7766

NEW YORK

NEW YORK

SBM Associates, Inc.
28 Hobby Street
Pleasantville, New York
Tel. (914) 769-1811

LONG ISLAND

SBM Associates, Inc.
528 Old Country Road
Plainview, Long Island
Tel. (516) 433-1421

ROCHESTER

SBM Associates, Inc.
800 Linden Avenue
Tel. (716) 381-8330

SYRACUSE

SBM Associates, Inc.
138 Pickard Bldg.
5858 E. Molloy Road
Tel. (315) 454-9377

NORTH CAROLINA

GREENSBORO

BCS Associates, Inc.
1039 E. Wendover Avenue
Tel. (919) 273-1918

OHIO

CLEVELAND

Technitron, Inc.
23203 Lorain Road
North Olmsted, Ohio
Tel. (216) 734-0960

DAYTON

Technitron, Inc.
1250 W. Dorothy Lane
Tel. (513) 298-9964

OREGON

PORTLAND

Instrument Specialists, Inc.
5950 Sixth Ave. South
Suite 106
Seattle, Washington
Tel. (206) 767-4260

PENNSYLVANIA

PHILADELPHIA

Acromatix Associates, Inc.
3118 Germantown Pike
Fairview Village, Pennsylvania
Tel. (215) 279-0377

PITTSBURGH

Technitron, Inc.
114 Spring Grove Road
Tel. (412) 371-1231

TEXAS

DALLAS

Barnhill Associates
507B Bishop Street
Richardson, Texas
Tel. (214) AD 1-2573

HOUSTON

Barnhill Associates
Suite 203
3810 Westheimer
Tel. (713) NA 1-0040

WASHINGTON

SEATTLE

Instrument Specialists, Inc.
5950 Sixth Ave. South
Suite 106
Seattle, Washington
Tel. (206) 767-4260

WASHINGTON, D.C.

Electronic Marketing Associates
11501 Huff Court
Kensington, Maryland
Tel. (301) 946-0300

CANADA

BRITISH COLUMBIA

VANCOUVER

Allan Crawford Associates, Ltd.
5901 East Broadway
North Burnaby 2, B.C.
Tel. (604) 291-7161

ONTARIO

OTTAWA

Allan Crawford Associates, Ltd.
376 Churchill Avenue — Suite 106
Tel. (613) 725-1288

TORONTO

Allan Crawford Associates, Ltd.
65 Martin Ross Avenue
Downsview, Ontario
Tel. (416) 636-4910

QUEBEC

MONTREAL

Allan Crawford Associates, Ltd.
6999 Cote de Neiges Road
Tel. (514) 739-6776

International Representatives

AUSTRALIA

Elmesco Instruments
41 Carter Road
Brookvale, N.S.W., Australia

AUSTRIA

Omni Ray AG
Techn. Beratung
Mollardgasse 54
Vienna VI, Austria

BELGIUM

C. N. Rood S/A
30 Rue Leon Frederic
Brussels 4, Belgium

DENMARK

Tage Olsen A/S
Ronnegade 1-0
Copenhagen, Denmark

FINLAND

Oy Findip AB Ltd.
Mannerheimintie 29C
Helsinki 25, Finland

FRANCE

S. E. R. I. E. L., s. a.
48 Avenue Victor Hugo
Clamart (Seine) France

HONG KONG and MACAO

Intronics Ltd.
4 Hankow Road, Suite 4A
Kowloon, Hong Kong

ISRAEL

R. D. T. Electronics
Engineering Ltd.
P.O. Box 21082
13 Dov-Hos Street
Tel-Aviv, Israel

ITALY

Elettronucleonica s. p. a.
7 Pizza DeAngli
20146 Milano, Italy

JAPAN

Toyo Trading Co., Ltd.
Central P.O. Box 999
Tokyo, Japan

Toyo Trading Co., Ltd.
4-37, Minamihonmachi
Higashika, Osaka, Japan

KOREA

M. - C International
Room 516, Bando Building
Seoul, Korea

THE NETHERLANDS

C. N. Rood N. V.
Post Office Box 4542
Rijswijk (Z. H.) The Netherlands

Fluke Nederland N. V.
Post Office Box 5053
Tilburg, The Netherlands

NEW ZEALAND

Sample Electronics (N. Z.) Ltd.
8 Matipo Street
Onehunga
Auckland, New Zealand

NORWAY

Morgenstierne & Co. A/S
Wesselsgt. 6
Oslo, Norway

OKINAWA

RYUKYU ISLANDS

Baxter Trading Co.
P.O. Box 26
Koza, Okinawa
Ryukyu Islands

PHILIPPINES

T. J. Wolff
2246 Pasong Tamo
Makati, Rizal
Manila, Philippines

SOUTH AFRICA

A. C. Gowlett (Pty.) Ltd.
P.O. Box 1257
Johannesburg, So. Africa

A. C. Gowlett (Pty.) Ltd.
P.O. Box 3641
Cape Town, So. Africa

A. C. Gowlett (Pty.) Ltd.
P.O. Box 2143
Durban, Natal, So. Africa

SOUTH VIETNAM

R. B. Landis & Co., Inc.
216 Hien-Vuong
P.O. Box H-3
Saigon, Vietnam

SPAIN

REMA
Calle General Sanjurjo, 18
Madrid, Spain

SWEDEN

Robert E. O. Olsson
Box 165
Tradgardsgatan 7
Motala, Sweden

SWITZERLAND

Omni Ray AG
Dufourstrasse 56
8008 Zurich, Switzerland

TAIWAN

Heighten Scientific Co., Ltd.
P.O. 1408
Taipei, Taiwan

THAILAND

G. Simon Radio Ltd.
30 Patpong Avenue
Suriwong
Bangkok, Thailand

THE UNITED KINGDOM

Fluke International Corp.
P.O. Box 102
Watford-Herts, England

WEST GERMANY

Rohde & Schwarz Vertriebs - Gmbh
5000 Koeln
Hohe Strasse 160-168
West Germany

Rohde & Schwarz Handels - Gmbh
1000 Berlin 10
Ernst - Reuter - Platz 10
West Germany

Rohde & Schwarz Vertriebs - Gmbh
2000 Hamburg 50
Grosse Bergstrasse 213-217
West Germany

Rohde & Schwarz Vertriebs - Gmbh
7500 Karlsruhe
Kriegsstrasse 39
West Germany

Rohde & Schwarz Vertriebs - Gmbh
8000 Muenchen
Dachauer Strasse 109
West Germany

In Europe contact FLUKE NEDERLAND, N. V., Post Office Box 5053, Tilburg, The Netherlands

FLUKE

List of Factory Authorized Service Centers

ARIZONA

PHOENIX

Arizona Standards Laboratory
4430 N. 19th Ave
Tel. (602) 264-9351

CALIFORNIA

LOS ANGELES

Instrument Specialists, Inc.
P. O. Box 39908
2870 Los Feliz Place
Tel. (213) 665-5181
TWX: 910-321-3914

COLORADO

BOULDER

Ball Brothers Research Corp.
Standardization Laboratory
Tel. (303) 444-5300
TWX: 910-940-3241

FLORIDA

ORLANDO

BCS Associates, Inc.
P. O. Box 6578
940 N. Fern Creek Ave.
Tel. (305) 425-2764
TWX. 810-850-0185

HAWAII

HONOLULU

Industrial Electronics
P. O. Box 135
646 Queen Street
Tel. (808) 506-095
TWX. 63238

MARYLAND

KENSINGTON

Electronic Marketing Associates
11501 Huff Court
Tel. (301) 946-0300
TWX. 710-825-9645

MASSACHUSETTS

ARLINGTON

Instrument Representatives, Inc.
1046 Massachusetts Ave.
Tel. (617) 646-1034

MICHIGAN

CLAWSON

Electro Instrument Repair
1024 W. 14 Mile Road
Tel. (313) 588-6688

NEW MEXICO

ALBUQUERQUE

EG & G Standards & Calibration
Laboratory
P. O. Box 8346
608 East Sunset Road
Tel. (505) 265-8481

NEW YORK

PLEASANTVILLE

SBM Associates
28 Hobby Street
Tel. (914) 769-1811
TWX. 710-572-2193

ROCHESTER

SBM Associates
800 Linden Ave.
Tel. (716) 381-8330
TWX. 510-253-6145

PENNSYLVANIA

PHILADELPHIA

Acromatix Associates, Inc.
3118 Germantown Pike
Fairview Village, Penn.
Tel. (215) 279-0377

TEXAS

GARLAND

Tucker Electronics Company
326 Kirby Street
Tel. (214) 272-3404

HUSTON

Linear Standards Laboratory
8207 Millet
Tel. (713) 923-2796

UTAH

SALT LAKE CITY

Stabro Laboratory
23 Kensington Ave.
Tel. (801) 467-8011

CANADA

TORONTO

Allen Crawford Associates Ltd.
65 Martin Ross Ave.
Downsview, Ontario
Tel. (416) 636-4910
TWX. 610-492-2119

INTERNATIONAL

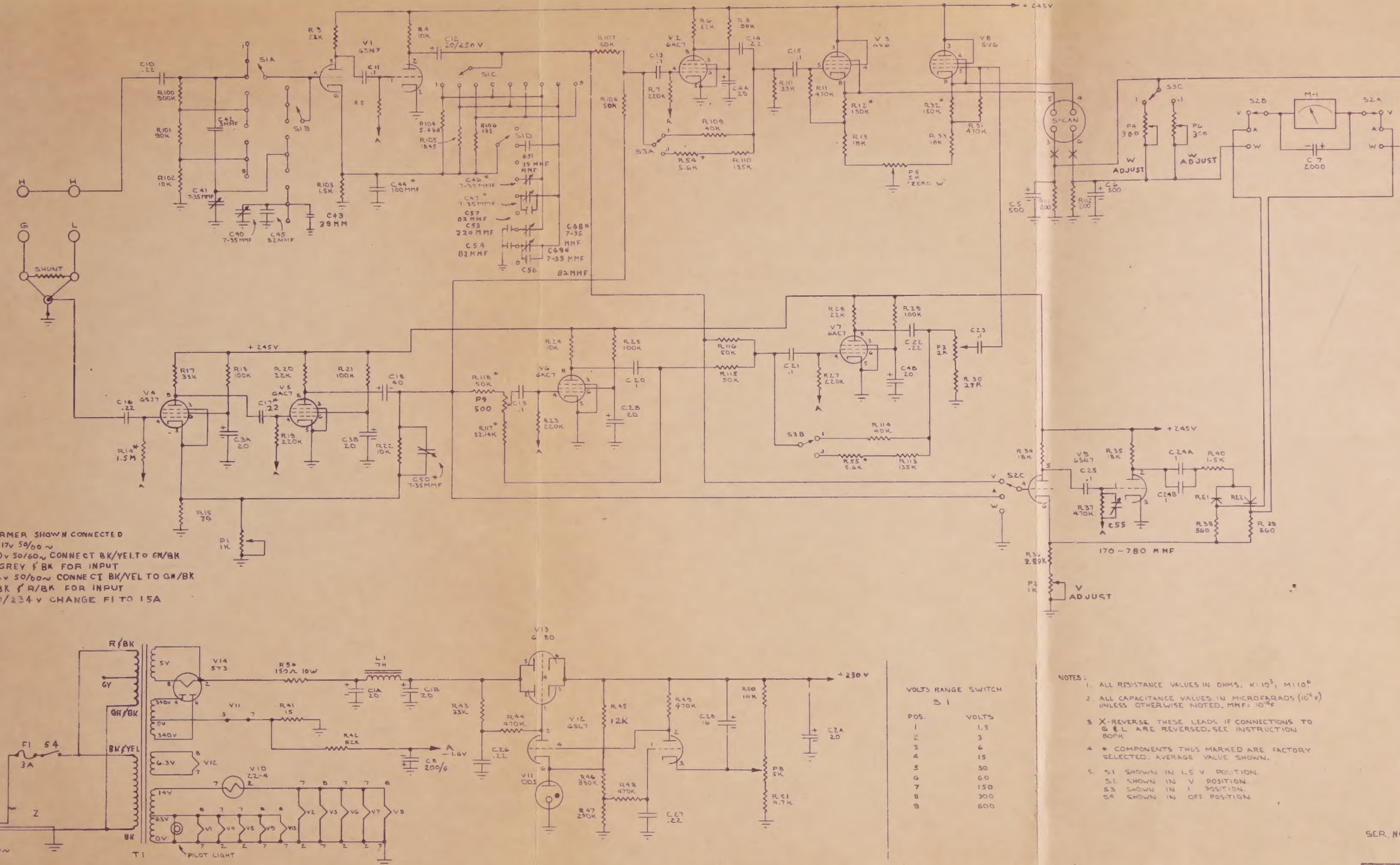
THE NETHERLANDS

Fluke Netherland N.V.
P. O. Box 5053
Tilburg, The Netherlands

UNITED KINGDOM

Fluke International Corp.
P. O. Box 102
Watford-Herts, England

For information regarding service centers in other foreign locations, contact the nearest Sales and Service Representative in your area.


+245V
R3 22K
V1 6SN7
R4 10K
C12 20/250V
C10 .22
S1A
S1B
S1C
S1D
C11 .1
R5
R100 900K
R101 90K
R102 10K
C42 3MMF
C41 7-35MMF
C90 7-35MMF
C95 82MMF
C43 39MM
R103 1.5K
C44* 100MMF
R104 5.44K
R105 1845
R106 135
C51 39 MMF
C46* 7-35MMF
C47* 7-35MMF
C57 82MMF
C53 220MMF
C54 82MMF
C48* 7-35 MMF
C49* 7-35 MMF
C56 82MMF
R107 50K
R108 50K
V2 6AC7
R6 22K
R8 100K
C13 .1
C14 .22
C4A 20
R7 220K
R109 40K
S3A
R54* 5.6K
R110 135K
C15 .1
R111 33K
R11 470K
V3 6V6
V8 6V6
R12* 150K
R13 18K
R32* 150K
R33 18K
R31 470K
P5 5K "ZERO W"
S-CAN
C5 500
R111 200
R112 200
C6 500
S3C
P4 300
P6 300
W ADJUST
W ADJUST
S2B
M-1
S2A
C7 2000
H
H
G
L
SHUNT
+245V
V4 6SJ7
R17 33K
R18 100K
R20 22K
V5 6AC7
R21 100K
C18 40
C16 .22
C17* .22
R14* 1.5M
C3A 20
R19 220K
C3B 20
R22 10K
C50* 7-35MMF
R15 79
P1 1K
R118* 50K
P9 500
R117* 52.14K
C19 .1
V6 6AC7
R24 10K
R25 100K
R23 220K
C20 1
C2B 20
R116 50K
R115 50K
V7 6AC7
R28 22K
R29 100K
C21 .1
R27 220K
C22 .22
C4B 20
P3 2K
R30 27K
C23 .1
S3B
R114 40K
R55* 5.6K
R113 135K
S2C
+245V
R34 18K
V9 6SN7
R35 18K
C25 .1
R37 470K
C55
C24A 1
C24B 1
R40 1.5K
RE1
RE2
R38 560
R39 560
170 – 780 MMF
R36 3.89K
P2 1K
V ADJUST
R/BK
GY
GN/BK
BK/YEL
BK
T1
F1 3A
S4
Z
117V 50/60~
5V
340V
0V
340V
6.3V
14V
6.3V
0V
V14 5Y3
R50 150Ω 10W
L1 7H
C1A 20
C1B 20
V11
R41 15
R42 82K
A −1.6V
C8 200/6
V12
V10 22-4
PILOT LIGHT
V13 6080
R43 33K
R44 470K
C26 .22
V12 6SL7
V11 OD3
R45 12K
R46 330K
R47 270K
R48 470K
C27 .22
R49 470K
C28 16
R50 14K
P8 5K
R51 4.7K
C2A 20
+230V

TRANSFORMER SHOWN CONNECTED
FOR 117v 50/60~
FOR 220v 50/60~ CONNECT BK/YEL TO GN/BK
USE GREY & BK FOR INPUT
FOR 234v 50/60~ CONNECT BK/YEL TO GN/BK
USE BK & R/BK FOR INPUT
FOR 220/234 v CHANGE F1 TO 1.5A

VOLTS RANGE SWITCH
S 1

POS.	VOLTS
1	1.5
2	3
3	6
4	15
5	30
6	60
7	150
8	300
9	600

NOTES:
1. ALL RESISTANCE VALUES IN OHMS. $K = 10^3$, $M = 10^6$
2. ALL CAPACITANCE VALUES IN MICROFARADS (10^{-6} F) UNLESS OTHERWISE NOTED. MMF = 10^{-12} F
3. X-REVERSE THESE LEADS IF CONNECTIONS TO G & L ARE REVERSED. SEE INSTRUCTION BOOK
4. * COMPONENTS THUS MARKED ARE FACTORY SELECTED. AVERAGE VALUE SHOWN.
5. S1 SHOWN IN 1.5 V POSITION.
S2 SHOWN IN V POSITION.
S3 SHOWN IN 1 POSITION.
S4 SHOWN IN OFF POSITION.

SER. NO. 950 & ON

JOHN FLUKE MFG. CO. INC.
SEATTLE, WASH.

102 CIRCUIT DIAGRAM

MODEL 102	DWG NO 102-1-7	
DATE 5/4/8	DRAWN B. BARR	CHECKED

www.manualsplus.com
1029173